INFLUENCE OF SOWING DATES ON YIELD AND YIELD COMPONENTS IN MAIZE SEED PRODUCTION

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Abstract: An experiment to determine optimum sowing dates for maize seed production in the Southern Telangana region of Andhra Pradesh was carried out at Seed Research & Technology Center, ANGRAU, Hyderabad during *Kharif,* 2013 using parental lines (BML 6 & BML 7) of maize hybrid, DHM 117 and were sown at monthly intervals *i.e.,* June 15th, July 15th, August 15th, September 15th. Sowing dates significantly influenced cob length, number of seeds row^{-1}, shelling %, seed yield plant^{-1} and test weight. Decrease in yield components like cob length, number of seeds row^{-1}, shelling % and test weight were noticed with delayed sowings. Seed yield decreased with delayed sowing dates (from June 15th to September 15th) and the per cent reduction in seed yield plant^{-1} with delay in sowings was 78.2%. The highest seed yield plant^{-1} (202.58 g), maximum cob length (21.0 cm) and number of seeds row^{-1} (43.0) were recorded for June 15th sowing. Difference in temperatures prevailed during early (26.14^{o}C) and late (22.35^{o}C) sowings aggravated the ill effects of soil temperatures causing desiccation of pollen grains there by adversely affecting fertilization leading to less number of effective seeds. Besides, low leaf area index and dry matter production plant^{-1} might have also led to low availability and reduced translocation of photosynthates to the developing cobs resulting in poor seed filling and ultimately less seed yield. Therefore from the present study it was observed that June 15th sowing was found ideal to obtain higher seed yield.

Keywords: Sowing date, maize, yield and seed production.

Introduction: In India, maize is cultivated annually in an area of 8.67 m ha with total production and average productivity of 21.60 m t and 2492 kg ha^{-1}, respectively (INDIASTAT, 2012). In Andhra Pradesh, maize is grown in an area of 7.44 l ha contributing to annual production of 39.53 lakh tonnes with an average productivity of 5317 kg ha^{-1} (INDIASTAT, 2011). One of the most important factors contributing to yield gap is sowing of maize on inappropriate dates. For optimum production seed must be sown on proper time. Considerable reduction in yield occurs if the crop is sown either too early or too late (Chaudry, 1994). Ismail (1996) reported increased maize yield with early sowings. Shafshak *et al.* (1995) concluded that a delay in sowing reduced a wide variety of plant and ear growth parameters and early sowing (1st May) resulted in highest yield. Planting date is an important factor in farming which has significant impact on crop growth and development and its yield and yield components (Mashreghi *et al.,* 2014). Delay in sowing reduced yield of maize (Mascagni and Boquet, 1996). Nafzinger (1994) has concluded that an optimum date of planting exists and that planting before or after the optimum date results in yield reduction. Hassan (1998) observed that delay in sowing decreased number of rows ear^{-1}, number of grains row^{-1}, number of grains ear^{-1}, grain weight and grain yield of maize. Cantarero (2000) found that late sowing reduced number of ears plant^{-1}, number of grains ear^{-1} and grain yield. Khan *et al.* (2002) reported decreasing trend in number of grains row^{-1}, 100 grain weight and grain yield with delay in sowing date. Planting date was reported to affect the growth and yield of maize significantly. Amjadian *et al.* (2013) reported that planting in first week of June (4th) was the best time for realizing higher seed yield and many other measured traits like length of corn, number of rows cob^{-1}, number of seeds row^{-1}, number of seeds corn^{-1} and cob weight. While planting on June 19th recorded lowest seed yield in corn, due to severe reduction in seed number but recorded maximum 1000 seed weight. Non significant differences in yield and other yield attributing characters were noticed between May 4th and May 19th planting dates. Keeping in view the importance of sowing dates in maize crop the present investigation was carried out to know the effect of sowing dates on seed yield and yield components in maize seed production.

Materials And Method: An experiment was conducted during rainy season, 2013 at Seed Research and Technology Centre, Rajendranagar, Hyderabad. Female (BML 6) and male (BML 7) parents of DHM 117 *i.e.* were sown in 4:1 ratio, at different sowing dates with monthly intervals *i.e.*, 15-06-2013, 15-07-2013, 15-08-2013 and 15-09-2013. The experiment was laid out in a randomized block design with five replications. Integrated crop management practices were followed to raise a healthy crop. The monthly meteorological data pertaining to rainfall, temperature and relative humidity and sun shine hours prevailed during crop growth period from June to December 2013 was obtained from the Meteorological Observatory located at Agricultural Research Institute, Rajendranagar, Hyderabad. Mean meteorological data during crop growth period at fortnight of each month are presented in Table 1. Data on cob length, number of seeds per row, shelling %, seed yield plant^{-1} and test weight were recorded on ten randomly selected cobs from the seed parent. Maize seeds were separated from ten cobs of known weight and shelling (%) was calculated by using the formula.

$$\text{Shelling percentage} = \frac{\text{Seed weight (g)}}{\text{Cob weight (g)}} \times 100$$

After cleaning, the weight of seeds of earlier selected cobs was recorded in grams individually. The mean was worked out and expressed as seed yield plant^{-1} in grams. The data obtained from present investigations was subjected to statistical analysis following the standard procedure, given by Panse and Sukhatme (1985). Critical differences were calculated at 5 per cent level. Correlations were also worked out to see the relationship between shelling %, test weight and seed yield plant^{-1} with weather parameters like minimum temperature, maximum temperature, RH I and RH II.

Results And Discussion: The data presented in Table 2 showed significant differences among the treatments for the characters studied. The data presented in Table 3 showed that the cob length varied significantly among the treatments and ranged from 13.8 cm to 21.0 cm with an average cob length of 18.0 cm (Table 3). Sowing on June 15th produced long cobs (21.0 cm) followed by July 15th sowing (20.2 cm) and were significantly different from other sowing dates (Table 3). August 15th sowing produced long cobs (17.0 cm) than September 15th sowing (13.8 cm). Decrease in cob length was noticed with the delay in sowings and was in conformity with the findings of Ibrahim *et al.* (2013) who reported that delayed sowing of maize from optimum sowing date would result in shorter cobs. These results were in contrast with the findings of Maddonni *et al.* (1998) who reported that decreased incident solar radiation early in the season reduced both cob length and cob mass through reductions in biomass production. As climatic conditions become more adverse, the ears became shorter, the kernels became shallower and the yield became lower (Martin *et al.,* 1976). The results (Table 3) indicated that sowing dates had a significant effect on number of seeds row^{-1}. Number of seeds decreased with delay in sowing and the per cent decrease in seed number was 61.67% as the sowing was delayed from 15th June to 15th September. Maximum seeds row^{-1} was observed in crop sown on 15th June (43.0) followed by crops sown on 15th July (36.9), while minimum seeds row^{-1} was observed in crop sown on 15th September (16.5). The maximum number of seeds row^{-1} with early sowing might be due to prolonged reproductive period which enabled the plants to produce more dry matter which was further effectively utilized by prolonged seed filling period, resulting in more seeds row^{-1}. These results were in agreement with Hassan (1998) who found that number of seeds row^{-1} and other yield components like number of rows cob^{-1} and 1000 grain weight of maize decreased with delay in sowing date. The increase in seed number cob^{-1} or seeds row^{-1} at optimum planting date was in contrast with the findings of Harris *et al*. (1984) who found that variation in planting date had a negligible influence upon the number of seeds cob^{-1}.

Significant variation was found among the sowing dates for shelling per cent (Table 3). Shelling per cent ranged from 68.46 to 80.46 with a general average of 76.10 per cent. Higher shelling per cent was recorded with August 15th sowing (80.46%) followed by June 15th sowing (79.84%) and lower shelling per cent was recorded with September 15th sowing (68.46). In general, difference in temperatures prevailed during early (26.14 ^{o}C) and late (22.35 ^{o}C) sowings aggravated the ill effects of soil temperatures causing desiccation of pollen grains and there by adversely affecting fertilization leading to less number of effective seeds. Besides, low leaf area index and dry matter production plant^{-1} might have led to low availability and reduced translocation of photosynthates to the developing cobs resulting in poor seed filling and ultimately less seed yield.

Significant variation was noticed among the sowing dates for seed yield plant^{-1} (Table 3). The average seed yield plant^{-1} was 137.17 g and ranged from 44.14 g to 202.58 g. Higher seed yield plant^{-1} was recorded with June 15th sowing (202.58 g) followed by July 15th sowing (164.88g) and lower seed yield plant^{-1} was recorded with September 15th sowing (44.18g) (Fig. 1). Maximum seed yield plant^{-1} with early sowing might be due to prolonged growing period leading to more number of seeds row^{-1} and high grain weight. Varma (2013) reported that soil conditions at different planting dates will inevitably be different and unfavourable conditions like extreme deficiency of soil moisture and incidence of pests and diseases *etc.,* may occur at almost any point during the normal planting dates. Consequently the observed difference in the performance of crops sown on different dates are commonly a reflection of difference in seed yield. Gallagher *et al.* (1975) reported that delay in planting date generally result in decreased individual grain mass, cob number plant^{-1} and eventually decrease the grain yield. The grain yield was observed to have significantly declined with delayed sowing i.e., 78.2% decline in grain yield was noticed as the sowing was delayed from June 15th to September 15th. This could probably be as a result of the effect of yield components on grain yield. The decrease in yield components with delay in sowing date might have affected the final grain yield. Elemo (1991) stated that the yield components decreased with delay in sowing.

Sowing dates had significantly affected test weight. Decreasing trend in test weight was observed with delayed sowing. The average test weight of 26.71 g was recorded which ranged from 22.38 g to 30.17 g. Crop sown on 15th July registered maximum test weight (30.17 g) followed by June 15th sowing (28.99 g) while minimum test weight (22.38 g) was recorded in crop sown on last date *i.e.,* 15th September. Delay in sowing date reduced individual kernel weight. Late sowings decreased the effective rate of grain filling and shortened the effective duration of grain filling compared with earlier sowings. Plant growth rate during grain filling was slower in later plantings because of low daily incident radiation and radiation use efficiency. There were no differences in the number of endosperm cells formed among sowings; thus, the potential capacity of kernels to accumulate assimilates did not contribute to the low final weight observed in later plantings. The effective duration of grain filling depends on the availability of assimilates and on the rate of grain filling when sowing was delayed. Reduction in the source of assimilates at later sowing dates caused lower kernel weight at harvest. The heavier grains with earlier planting might be due to prolonged growing and grain filling period which enabled the plants to produce bold and plump grains. These results were in conformity with the findings of Rizzardi *et al.* (1994), Cha and Chol (1995) who reported reduction in 1000 grain weight with delay in sowing date. Panwar and Yadav (1981) obtained bolder and heavier seed with early sowing in pigeon pea.

Character associations among various weather parameters and its association with physiological and yield attributing characters revealed significant positive correlations between seed yield plant^{-1} and test weight with maximum temperature, minimum temperature and relative humidity II indicating that as the maximum temperature, minimum temperature and relative humidity II increases seed yield increases (Table 4). Rajanikanth (2004) reported strong and positive correlation between seed yield and rainfall, RH II at (14: 30), wind speed and minimum temperatures. However, GDD was showing negative relationship with test weight and positive relationship with seed yield plant^{-1}.

Sowing of parental lines of maize hybrid, DHM 117 on June 15th was found superior for realizing higher yields in Southern Telangana region of Andhra Pradesh which could be attributed to the correct synchronization of parental lines and prevailed optimum temperatures during grain filling and and grain formation stages.

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Table 1. Fortnightly distribution of minimum, maximum and mean temperatures (°C), rainfall (mm) and relative humidity (%) during crop growth period from June to December, 2013.

Dates	Temperature (^{o}c)			R.H. (%)		Average rainfall (mm)
	Maximum	Minimum	Mean	I	II	
15 to 30, June, 2013	31.9	24.3	28.1	80.7	53.7	3.2
01 to 14, July, 2013	30.7	25.2	28.0	82.1	68.0	6.1
15 to 31, July, 2013	27.5	22.4	25.0	89.0	78.8	6.1
01 to 14, August, 2013	27.9	21.9	24.9	87.7	71.9	5.8
15 to 31, August, 2013	29.2	21.9	25.6	91.8	79.0	4.5
01 to 14, Sept., 2013	31.1	21.0	26.1	86.9	64.6	3.9
15 to 30, Sept., 2013	31.0	20.2	25.6	87.3	64.1	3.5
01 to 14, Oct., 2013	30.8	21.4	26.1	85.6	62.4	1.4
15 to 31, Oct., 2013	29.3	18.1	23.7	91.5	63.4	13.7
01 to 14, Nov., 2013	28.8	14.6	21.7	84.6	49.3	0.0
15 to 30, Nov., 2013	28.1	14.2	21.1	87.7	51.4	1.9
01 to 14, Dec., 2013	28.4	10.7	19.5	82.2	36.8	0.0
15 to 31, Dec., 2013	27.7	9.6	18.6	83.8	36.4	0.0

Table 2. Mean squares from the analysis of variance for sowing date on cob length, number of seeds row^{-1}, shelling %, and seed yield plant^{-1} and test weight

Source of variation	Degrees of freedom	Mean squares				
		Cob length (cm)	Number of seeds row^{-1}	Shelling (%)	Seed yield plant^{-1} (g)	Test weight (g)
Replications	4	-	-	-	-	-
Treatments	3	53.92	643.04	148.44	22824.92	77.31
Error	12	1.33	9.55	5.16	407.10	3.35
Total	19	-	-	-	-	-

Table 3. Effect of sowing dates on yield attributing characters of seed parent of maize hybrid, DHM 117

Dates of sowing	Cob	Seeds row^{-1}	Seed yield	Shelling (%)	Test weight

	length (cm)	(no.)	plant^{-1} (g)		(g)
June 15th, 2013	21.0	43.0	202.58	79.84	28.99
July 15th, 2013	20.2	36.9	164.88	75.64	30.17
August 15th, 2013	17.0	31.6	137.07	80.46	25.30
September 15th, 2013	13.8	16.5	44.18	68.46	22.38
Grand mean	18.0	31.97	137.17	76.10	26.71
S.Em.±	0.51	1.38	9.02	1.01	0.53
S.Ed.	0.73	1.95	12.76	1.43	0.75
C.D.(0.05)	1.60	4.30	28.11	3.16	1.66
C.V. (%)	6.41	9.66	14.70	2.99	4.46

Table 4. Correlation coefficients among various weather parameters and yield attributing characters of maize

Weather parameters	Shelling (%)	Seed yield plant $^{-1}$	Test weight (g)
Maximum temperature (°C)	0.8749**	0.8834**	0.4765*
Minimum temperature (°C)	0.6960**	0.9564**	0.8089**
RH I (%)	0.4974*	0.3715	0.2742
RH II (%)	0.7036**	0.9410**	0.8252**
Growing degree days	-0.2187	0.6065**	-0.6118**

** significant at 1 % probability level
* significant at 5 % probability level

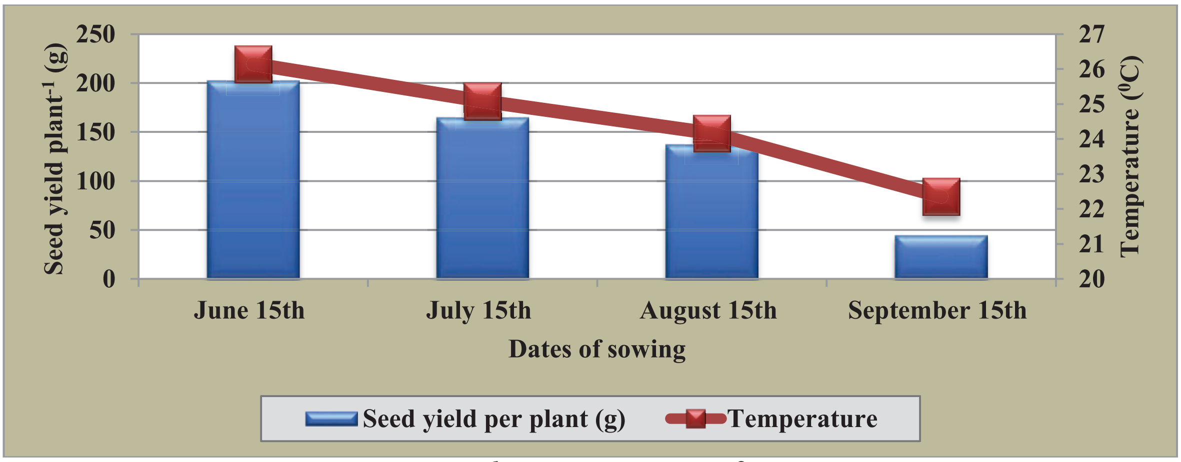

Fig.1. Relation between seed yield plant^{-1} and temperature (°C) at different sowing dates of seed parent in hybrid seed production plot of DHM 117

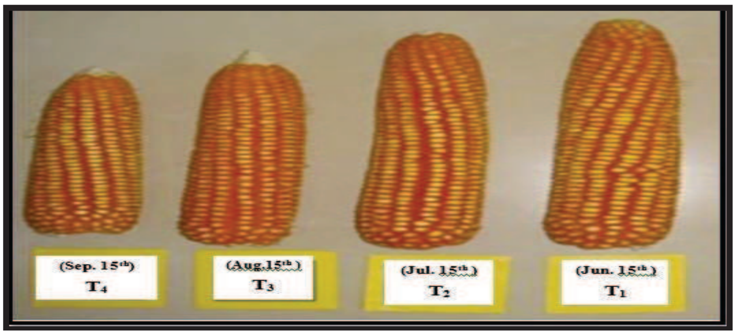

Plate 1. Effect of sowing dates on cob length (cm)

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